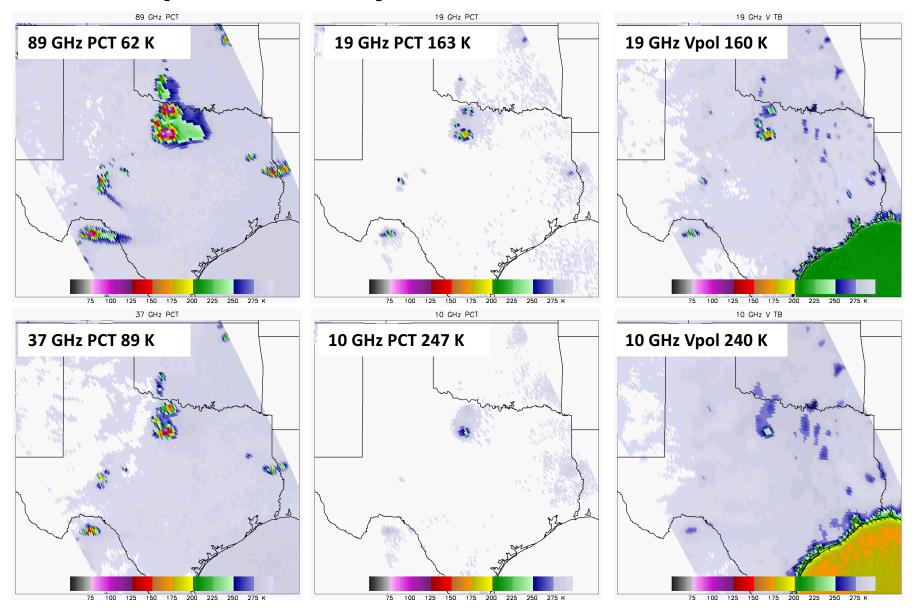# Hydrometeor Types From Dual-Pol Radar, Compared to GMI Brightness Temperatures

Daniel J. Cecil, NASA MSFC

Themis Chronis, U. Alabama – Huntsville

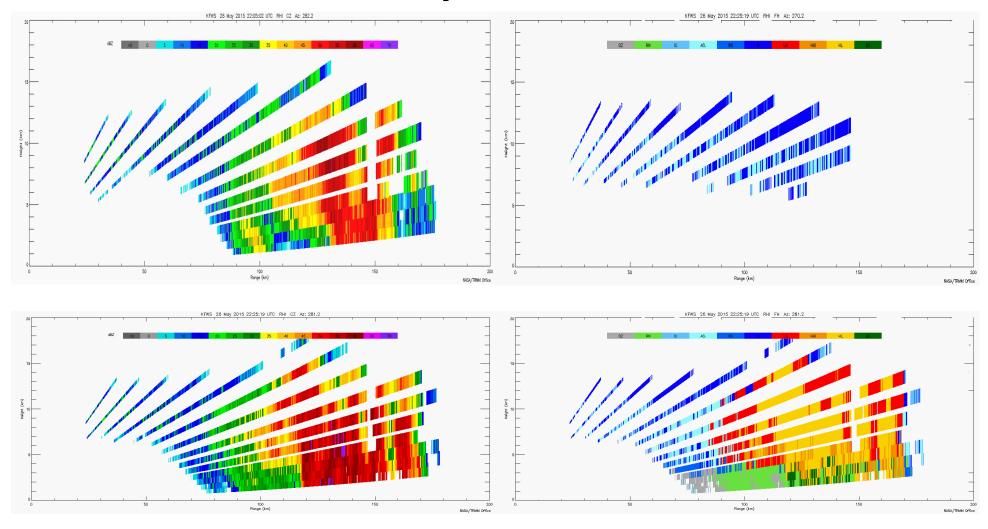Kenneth Leppert II, U. Louisiana - Monroe

Approach

- Use "Validation Network" (**VN**) of ground-based dual-polarization radars from GPM GV program (mostly Central and Eastern USA), together with GMI brightness temperatures
    - *Database is constructed using a minimum threshold for raining pixels, so inherently biased toward including precipitation*

- Hydrometeor ID (**HID**) (e.g., hail, high-density graupel, low-density graupel, aggregates, liquid rain, etc.) derived from dual-pol radar data

- Construct joint histograms and probability-of-occurrence for different hydrometeor types as a function of brightness temperature in different channels

- To facilitate use of low-frequency channels over land, construct polarization corrected temperatures (**PCT**) *(more on that later)*

Example – 26 May 2015, west of Ft. Worth

89 GHz PCT 62 K

19 GHz PCT 163 K

19 GHz Vpol 160 K

37 GHz PCT 89 K

10 GHz PCT 247 K

10 GHz Vpol 240 K

Intense storms in N. Texas stand out; PCT helps distinguish storms from lakes
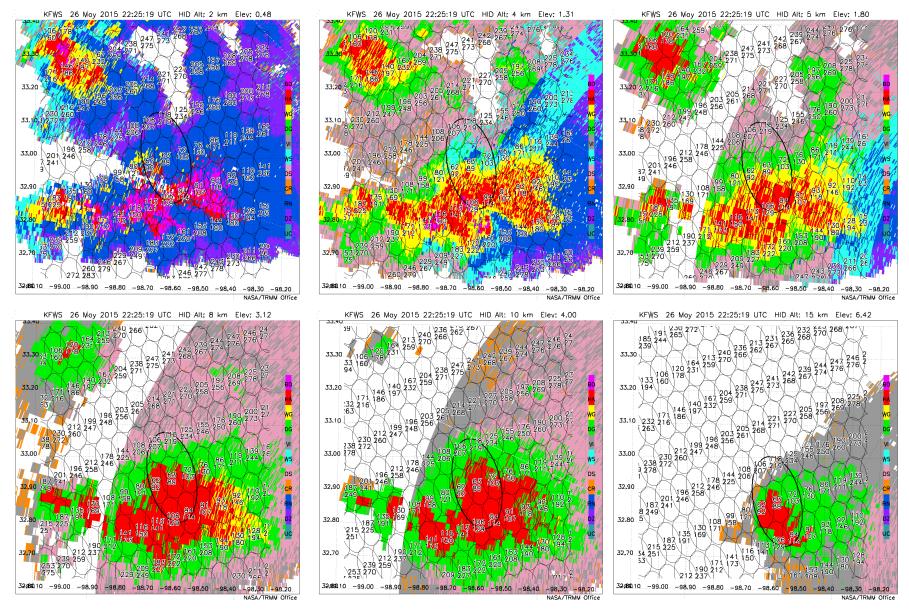
Radar RHI – 26 May 2015, west of Ft. Worth

Left: Radar Reflectivity   **Right: Hydrometeor Identification (HID)**

2025 UTC

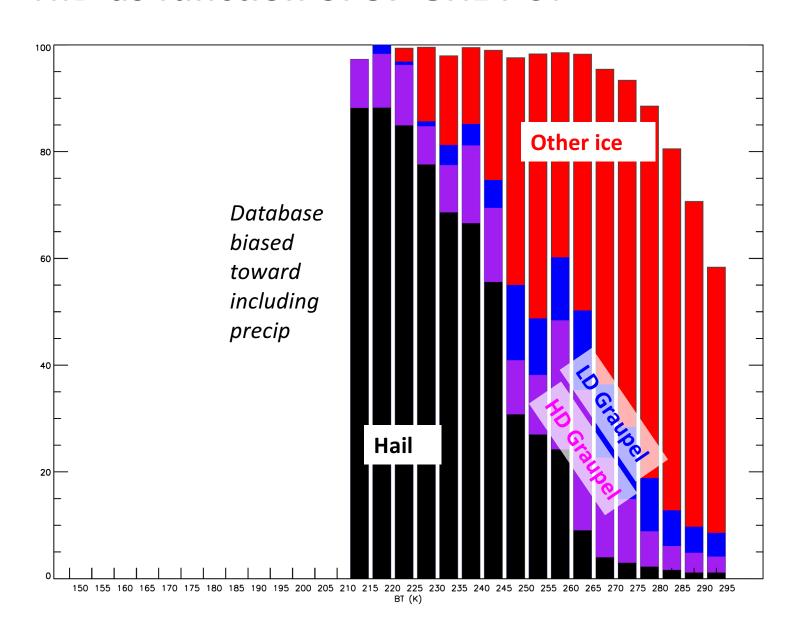# HID with height – 26 May 2015, west of Ft. Worth

HID shaded; numbers are GMI 89 GHz and 37 GHz PCT; coldest footprint highlighted

HID as function of 37 GHz PCT

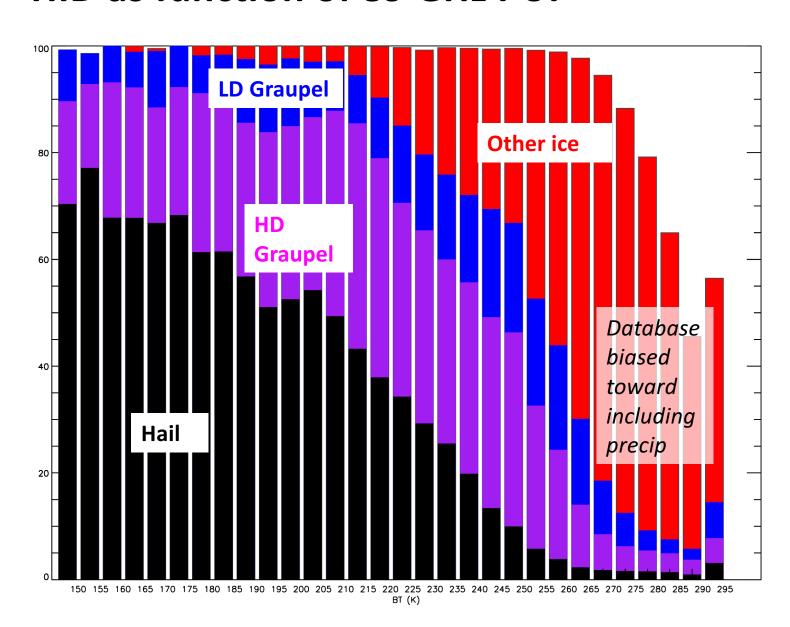Probability that a given HID occurs anywhere in the vertical column

Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.

Database biased toward including precip

Other ice
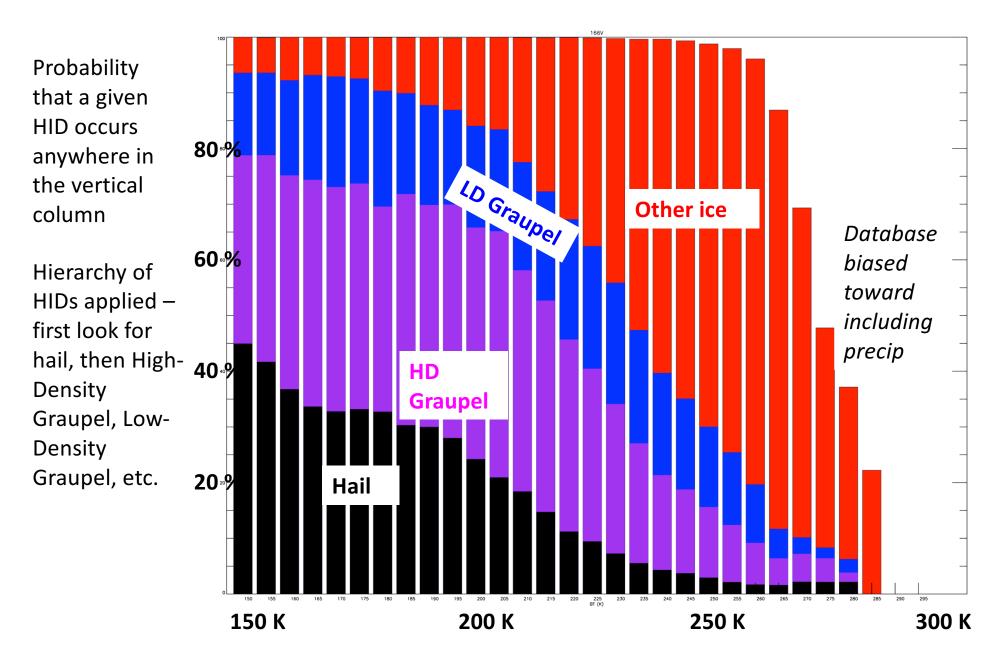
Hail

LD Graupel

HD Graupel

BT (K)

HID as function of 89 GHz PCT

Probability that a given HID occurs anywhere in the vertical column

Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.

Chart labels visible on figure: LD Graupel, HD Graupel, Other ice, Hail, *Database biased toward including precip*

X-axis: BT (K)

HID as function of 166 GHz V

Probability
that a given
HID occurs
anywhere in
the vertical
column

Hierarchy of
HIDs applied –
first look for
hail, then High-
Density
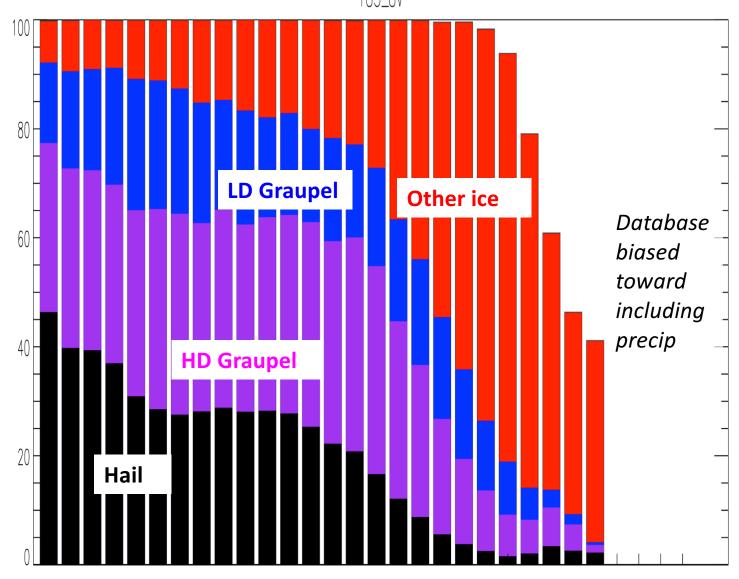Graupel, Low-
Density
Graupel, etc.

*Database
biased
toward
including
precip*

LD Graupel

Other ice

**HD
Graupel**

Hail

80%

60%

40%

20%

150 K   200 K   250 K   300 K

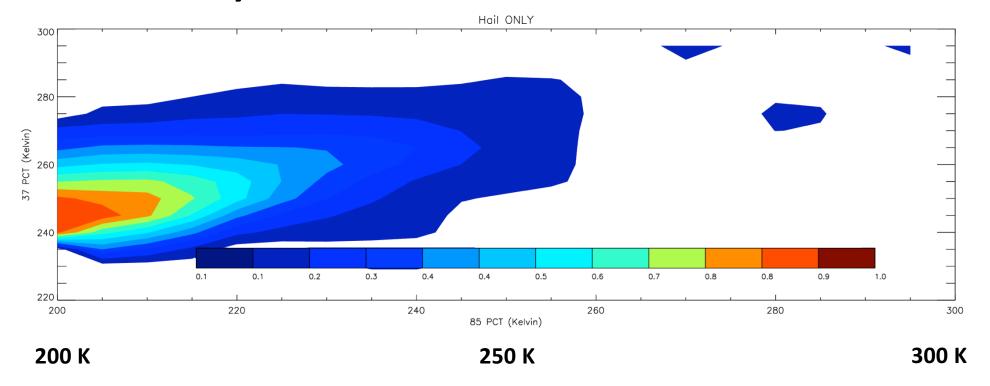# HID as function of 183+/-7 GHz V

Probability that a given HID occurs anywhere in the vertical column

Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.
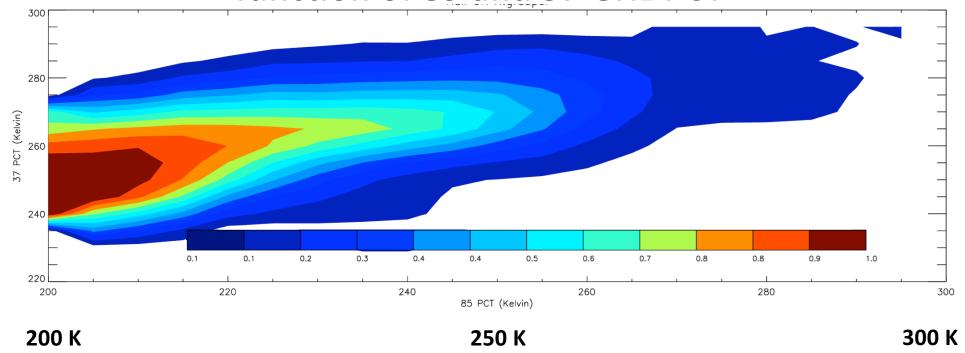
Database biased toward including precip

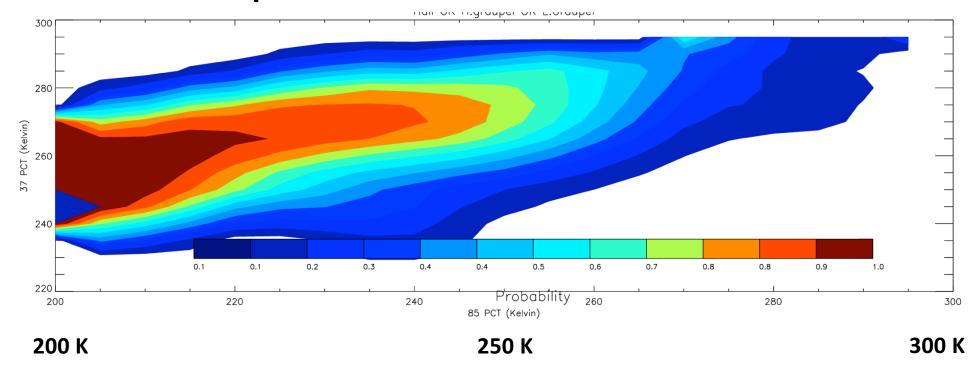# Probability of Hail as function of 89 and 37 GHz PCT

200 K   250 K   300 K

Probability of Hail or High Density Graupel as function of 89 and 37 GHz PCT

Probability of Hail, High Density Graupel, or Low Density Graupel as function of 89 and 37 GHz PCT

200 K   **250 K**   **300 K**
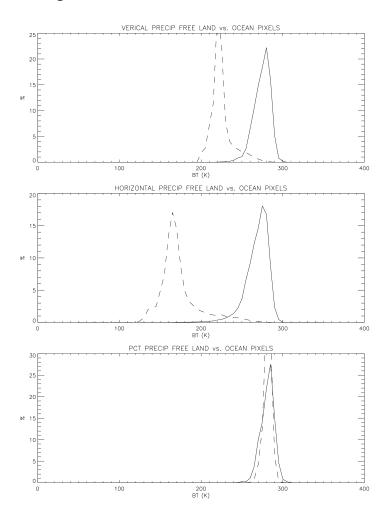
Polarization Corrected Temperature (PCT) concept

Vertically (top) and Horizontally (middle) polarized channels have very different brightness temperature distributions for rain-free pixels

Polarization Corrected Temperature (PCT; bottom) is intended to make those distributions similar to each other
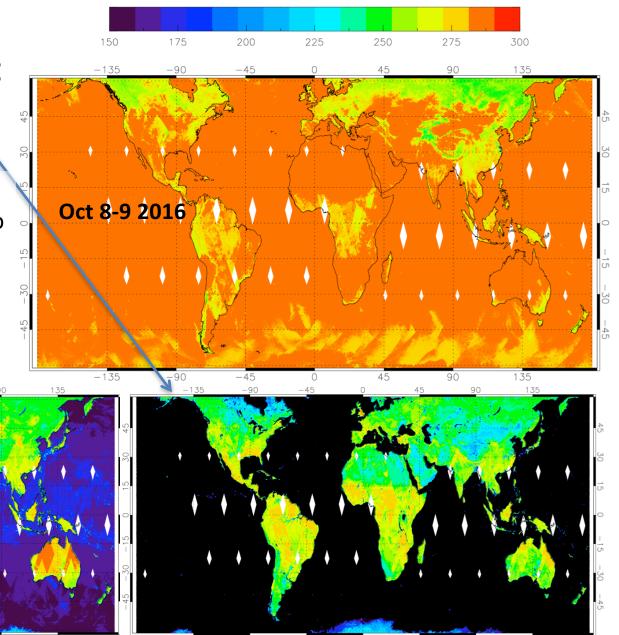
$$PCT = (A+1) * TB_V - A * TB_H$$

Coefficient A is empirically derived, separately for each frequency

PCT should reduce Land-Water contrast

PCT10 = 2.86 * V10 – 1.86 * H10

- This also eliminates much of the precip signal, but does help highlight the strongest storms

- Might want to use this by looking at joint probabilities by PCT10 and V10
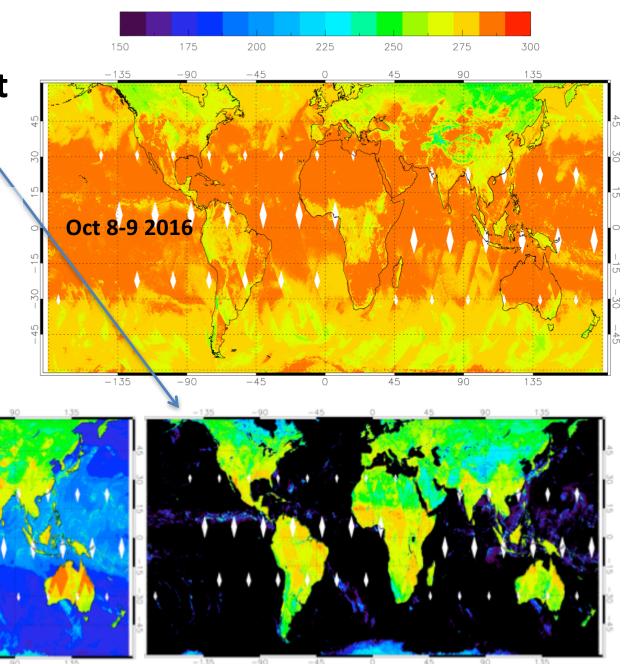

10_GHz PCT Kelvin

Oct 8-9 2016

PCT should reduce Land-Water contrast

PCT19 = 2.55 * V19 – 1.55 * H19

- Some coefficient values are better for specific latitudes / seasons, but preference is to apply one value everywhere

Oct 8-9 2016

19_GHz PCT Kelvin

Summary

- Combination of GMI with ground-based dual-pol radar database allows examination of Hydrometeor Type versus Brightness Temperature

- We assume that high density-ice (hail, graupel) dominates the signal if it is present somewhere in the column

- Polarization Corrected Temperature (PCT) developed for 10, 19 GHz

  - Can help distinguish very strong convection versus surface water bodies

  - 37, 89 GHz versions are already widely used, no need to replace those

  - 166 GHz, 183 GHz have little contribution from the surface any way, so little reason for PCT at those frequencies

- Using combinations of frequencies can help, but we are early in that work